Application of Laser GHz Ultrasound to Mesoscale Materials

Robert Huber
(925) 424-2002
huber5@llnl.gov

Laser-based ultrasound offers non-contact nondestructive characterization for materials and structures. A state-of-the-art laser-based ultrasound system has been installed at LLNL and demonstrated on numerous mesoscale samples. Mesoscale (µm scale features and up to mm extent) materials and their characterization are of increasing importance at LLNL in many fields, including high-energy-density physics (HEDP) and other National Ignition Facility (NIF) targets, and medical applications for determination of tissue health.

Project Goals

The goal of this work was to set up a laboratory housing the state-of-the-art GHz laser-based ultrasound system and demonstrate its ability to characterize mesoscale materials.

Relevance to LLNL Mission

The National Ignition Facility is, and will continue to be, a major program at LLNL. This facility offers a unique capability for conducting fusion and other HEDP experiments. The targets required for these experiments will be some of the most complex ever devised, and characterizing these targets prior to testing them is critical to determining the success of the experiments. These targets are mesoscale structures and, as such, require new nondestructive characterization tools.

FY2006 Accomplishments and Results

A new laser-based ultrasound laboratory was set up to house the GHz laser-based ultrasound equipment (Fig.1). Numerous samples, including metal foils and samples with two layers

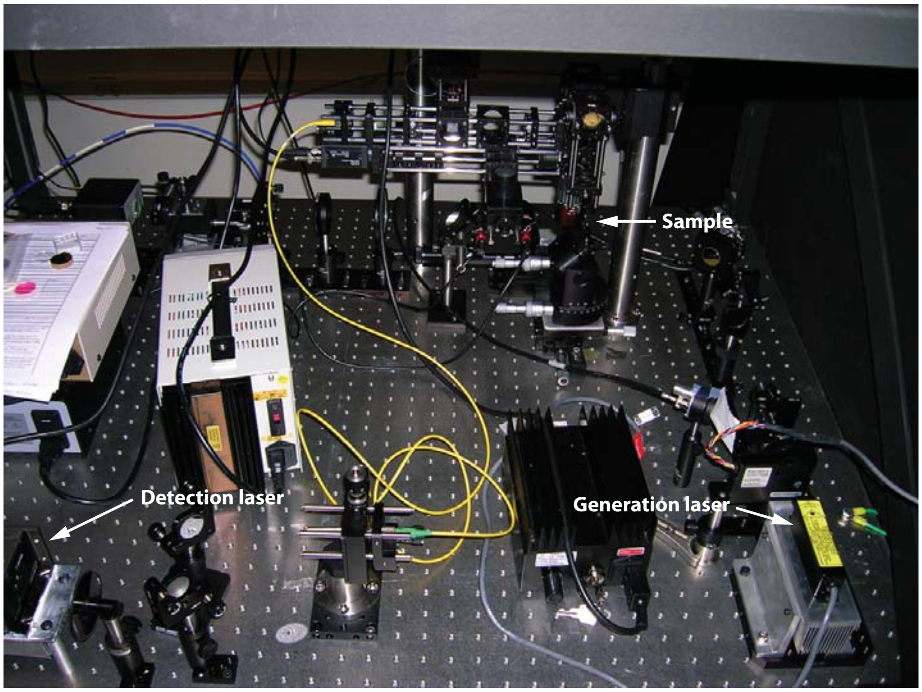

Figure 1. GHz laser-based ultrasound system.

were tested. Raw and filtered waveforms for a 25-µm-thick gold foil are shown in Fig. 2. Raw and filtered waveforms for a two-layer (Al-Cu) sample are provided in Fig. 3. The Al and Cu thicknesses were 63 µm and 35 µm, respectively. These tests demonstrated the system's high spatial resolution for thickness measurement as well as its ability to characterize bonds.

Ultrasound techniques are valuable for characterizing bonds. Translation stages were incorporated into the system to allow scanning of objects. Linear scans were performed, and work is proceeding to allow automated 2-D scans. Modifications were made to the system during the course of the year. These modifications are aimed at making the system more robust and user-friendly. It is anticipated that more modifications will be suggested as operators get more experience and think of ways to improve the system further.

Related References

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2. Martz, H. E., and G. F. Albrecht, "Nondestructive Characterization Technologies for Metrology of Micro/Mesoscale Assemblies," *Proceedings of: Machines and Processes for Micro-scale and Meso-scale Fabrication, Metrology, and Assembly,* ASPE Winter Topical Meeting, Gainesville, Florida, January 22-23, pp.131-141, 2003.

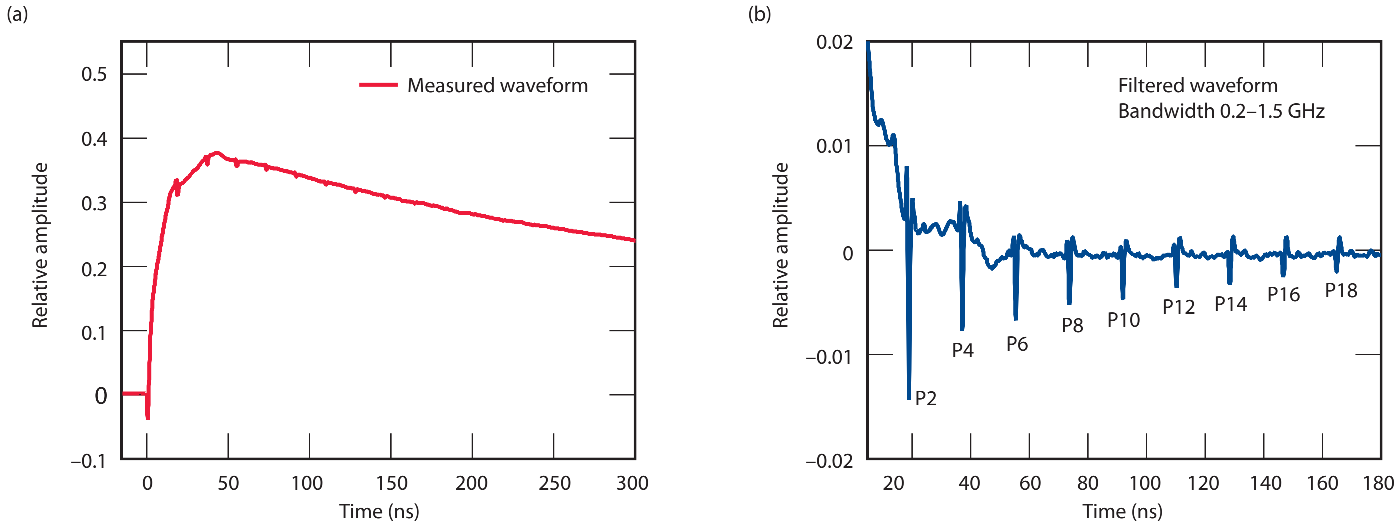

Figure 2. (a) Raw and (b) filtered waveforms on 25-mm-thick Au foil.

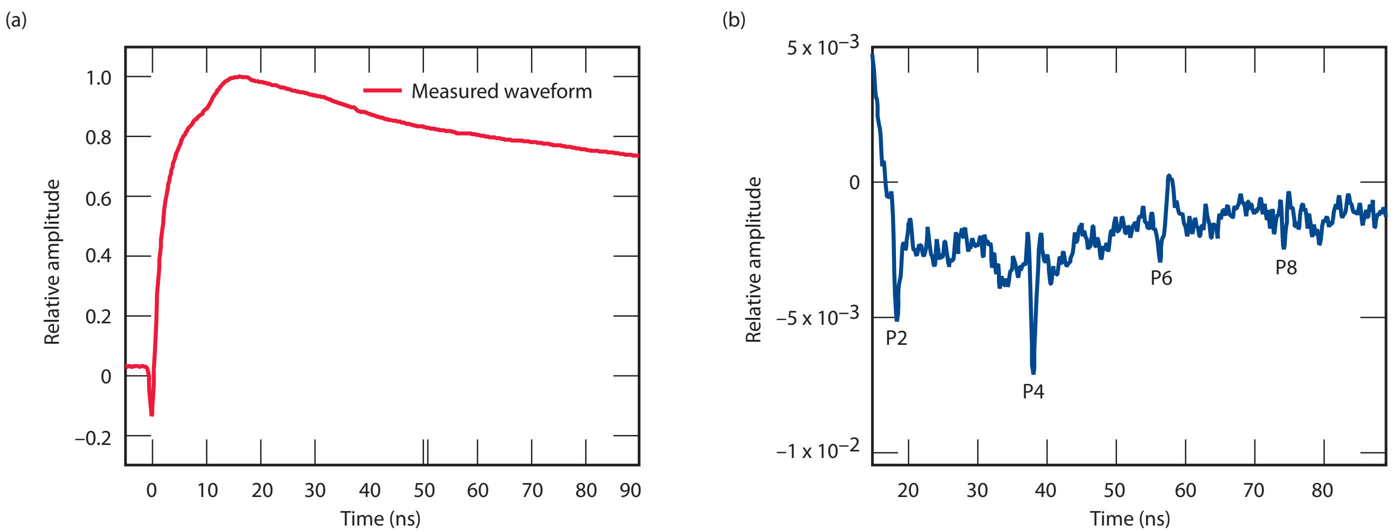

Figure 3. (a) Raw and (b) filtered waveforms on Al-Cu bonded sample.